CHAPTER III
THE FUTURE OF MARITIME ACTIVITIES

The maritime world of 20 years hence will be, for the most part, a much busier place. The forces and changes described in Chapter II not only will affect the types of activity occurring on the seas, but also will tend to increase the amount of maritime activity. The primary drivers of this increase in maritime activity will be the continued growth of the economic interdependence among states, the overall world population growth, the tremendous migration of people from developing states to developed states, and a projected significant increase in passenger carriers.

The oceans are vital to the overall growth of the world economy and population, and to the continued economic integration of nations. The oceans are a primary source of food, energy, and transportation, all key requirements of human activity in an interconnected world. Development of the oceans' natural resources and use of the oceans' highways for transport must increase to accommodate an ever-growing world.

Two primary challenges face the maritime states from now until 2020. First is the need to manage the growth in human use of the oceans with the need to protect the marine environment. Second is the substantial increase in illegal activity that will accompany the tremendous growth in legal maritime activity.

A. COMMERCIAL ACTIVITIES

1. Natural Resource Exploitation

> "The oceans are no longer viewed by the community of nations as a vast unregulated void or solely as a barrier to be crossed. Not only must America exert its influence to safeguard its economic and security interests, we must support efforts to protect the seas and defuse conflict that arise from competing demands for the sea's resources. This can be achieved only through the development of a comprehensive agenda for the ocean in the 21st century.[1]"
>
> *John Dailey*

a. Living Marine Resources

(1) Fishing Stocks. Worldwide demand for fish[2] will increase through 2020, stressing already fully fished and overexploited stocks, reinforcing the need for sound fisheries

[1] Draft, John Dailey, "Space and Oceans: Can They be Controlled?," Strategic Assessment 1999 (Washington, D.C.: Institute for National Strategic Studies, National Defense University, 1999), 460.
[2] For purposes of this section, "Fish " or "Fishing" also connotes shellfish and crustaceans.

management practices, and creating potential conflict among states competing for scarce fisheries resources. Marine fisheries production (the amount of fish caught, measured in tons) may increase to help meet the rising demand, but only through effective fisheries management. The United States faces both international and domestic challenges to ensure its fisheries remain sustainable.

The Food and Agriculture Organization of the United Nations (FAO) conservatively estimates that world demand for fish for human consumption will increase from 80 million tons in 1995 to 110-120 million tons in 2010.[3] Fish are an important source of protein for much of the world's population. All of the regions around the globe are expected to have an increased demand for fish in the future, especially Asia. Aquaculture, or fish farming, will help meet this rising demand, but marine fisheries will still be the primary source.

This rise in world demand for fish will place increasing stress on fish stocks, many of which are already overexploited. Of the top 200 marine fish resources in the world, over 60 percent require urgent management of the fishery because they are overexploited or fully fished. In North America, for example, the once robust cod fishery off the northeast coast of Canada is under moratorium because of overexploitation, and in Europe many groundfish stocks have been exploited so intensely that they are considered outside safe biological limits.[4]

Despite current depletion of fisheries stocks, it is possible that stocks as a whole may recover and remain at sustainable levels by 2010 should effective fisheries management practices be enacted and enforced. Many states are already taking steps, and the international community as a whole has recognized the need for fisheries management, adopting measures such as the UN Agreement on Conservation and Management of Straddling Stocks and Highly Migratory Fish (Straddling Stocks Agreement). The significance of the Straddling Stocks Agreement is its recognition that current fishing levels cannot be sustained at current harvesting rates. Under the FAO's optimistic scenario, where fisheries management is improved, marine fisheries production will meet heavy worldwide demand for fish in 2010. Under the pessimistic scenario, where fisheries management is ineffective, marine fisheries production drops below current levels, far below the expected demand in 2010.[5]

There are three key components to the future success of worldwide fisheries management. All of these components will have to be used to some extent over the next two decades throughout the world.

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[3] Food and Agriculture Organization of the United Nations (FAO), The State of World Fisheries and Aquaculture, (Rome, Italy: Food and Agriculture Organization, 1997), 24.

[4] ibid., 47, 65.

[5] ibid., 27.

(a) Reduction of fishing fleet size. Reducing fleet size by at least 30 percent is a first step required in protecting the world's fish stocks. Various plans to do this exist, such as retiring vessels, buying back permits, and limiting entry into a fishery as others' permits expire. The United States has just completed such an effort to reduce the size of the New England fleet. These efforts are less effective if capacity is simply transferred from one fishery to another, such as in places like Italy, China, and Taiwan, where conversion programs have allowed former high seas driftnetters to enter other fisheries.

Figure III-1. In order to protect fish stocks, the size of the New England fishing fleet was recently reduced.

(b) Reduction or elimination of subsidies. Several foreign governments subsidize fisheries at a worldwide cost of $10 billion annually, according to the United Nations.[6] These subsidies encourage overcapitalization and greater effort by fishermen, and they increase consumer demand.[7] Examples of subsidies include guaranteed low interest loans, subsidized commodity prices, and capital investment tax incentives.

(c) Limiting access. Today, fisheries managers are using several methods for limiting access to fisheries. One option, Individual Transferable Quotas (ITQs), establish property rights to what had previously been a public asset. Total-allowable-catches are established and divided among several quotas. These quotas may be bought and sold as property. The advantage of ITQs over programs like "days at sea" limitations is that ITQs give fishermen a vested interest in protecting their resource since they are only allowed to fish up to their quotas. Under a "days at sea" program, fishermen are limited in how many days they can fish, but there are no restrictions on the amount of fish they can catch during those days. Other programs for limiting access include closing specific areas to fishing (or to a particular fishery) and restricting access to an area to certain permitted vessels. These two programs are currently in place on Georges Bank in the Gulf of Maine.

[6] Allison Aubrey, "Morning edition" (text), National Public Radio, transcript, 26 October 1998, accessed from IC ROSE on 22 January 1998.

[7] Hans A. Binnennddijk and Patrick L. Clawson, eds., Strategic Assessment 1997: Flashpoints and Force Structure (Washington, D.C.: National Defense University Press, 1997), 223.

Full implementation of these measures worldwide will not be easy. These measures require the commitment of resources to compensate fishermen for their vessels and other capital removed from the business. They also require plans (and more resources) to help these displaced fishermen to earn a living in other sectors of the economy. Furthermore, in the face of escalating demand for fish, limiting access will require significant commitment to enforcing any restrictions on fishing. Enforcement will be required to ensure domestic fishermen are obeying restrictions and to protect fisheries from foreign exploitation.

International cooperation will be critical to the success of fisheries management endeavors. Fisheries issues are complex, and involve competing interests even among friendly states. Nearly 40 percent of the world's oceans are claimed as exclusive economic zones, and coastal states control almost 90 percent of the oceans' fish. One example of international cooperation is the ongoing multilateral conferences on establishing a mechanism for the conservation and management of highly migratory fish stocks in the Central and Western Pacific. The ambitious aim of the 23 countries involved is to manage highly migratory stocks over a 20 million square mile area, using tools such as a comprehensive registry of fishing vessels, a vessel monitoring system, and at-sea boardings of vessels whose countries are signatories to the eventual agreement.

Despite efforts at cooperation, however, international fishing disputes will be inevitable. Disagreements among coastal states and coastal state enforcement measures will likely lead to conflict, and even violence, as countries grapple with balancing the need for food with the need to sustain the resource. Conflicts already in evidence today will be more prevalent in 2020.

Fishing is such an important part of many coastal country economies that it often reaches into the social fabric of society. If the depletion of fishing stocks continues, we may well reach a point where security concerns over fishing rights approach the level of the concerns presently being dealt with in regard to water rights in the Middle East.[8]

For the United States, fisheries management and enforcement will be a major concern through 2020, both internationally and domestically. The U.S. commercial fishing fleet contributed nearly $50 billion to the economy in 1995.[9] The United States has the largest exclusive economic zone (EEZ) in the world, and it contains an estimated 20 percent of the world's fishery resources. Should the United States be successful in managing its fisheries, U.S. waters will become even more attractive to foreign fishermen than they are today. In FY98, the U.S. Coast Guard detected 218 encroachments of the

[8] Draft, John Dailey, "Space and Oceans: *Can They be Controlled?*," Strategic Assessment 1999 (Washington, D.C.: Institute for National Strategic Studies, National Defense University, 1999), 458
[9] ibid., 457.

U.S. EEZ by foreign fishing vessels. That number will likely increase through the next 20 years because of overfishing in other areas of the world. For example, many fisheries in Asian waters are overexploited, or even depleted, while demand there is expected to increase substantially. The FAO notes that the East Asian region will probably have a high dependence on distant water fishing in the next decade to satisfy demand.[10] Bountiful U.S. Pacific waters would be a lucrative target for Asian fishermen.

For U.S. fisheries to be attractive to foreign fishermen, however, there must first be effective fisheries management at home. Fish stocks in the United States will only be at sustainable levels in 2020 if adequate fisheries management tools are implemented and enforced. This will require short-term sacrifice (e.g., reducing the number of fishing vessels and limiting access to fisheries) in the fishing industry for long-term gain, and long-term devotion of resources by the government to fisheries management and enforcement programs.

(2) Endangered Species. The number of endangered marine species in U.S. waters likely will not increase by 2020, assuming adequate fisheries management programs are in place. Marine management is looking more and more to preserving ecosystems rather than individual species, broadening the scope and improving the efficiency of marine protection measures. Changes in abundance and distribution of one species affect the distribution of other species as well, and single species approaches are no longer adequate for modern fisheries management. Of the 174 stocks of marine mammals

Figure III-2. Protecting marine mammals will remain a challenge through 2020.

[10] Food and Agriculture Organization of the United Nations (FAO), The State of World Fisheries and Aquaculture (Rome, Italy: Food and Agriculture Organization, 1997), 63.

and sea turtles, 42 are on the endangered species list or considered depleted over a significant portion of their range.[11] By 2020, the number of endangered or depleted species will not appreciably increase, and will likely decrease.

Marine mammal populations within the U.S. exclusive economic zone are expected to remain at current levels or increase through 2020, dependent in large part on how well the United States succeeds in preserving ecosystems and managing fisheries (maintaining food sources, enforcing no-trawl zones in vicinity of stellar sea lion rookeries, etc.). Collisions with ships and entanglement with fishing gear will loom as an ever-present hazard for large mammals such as the right whale, whose number has dropped to nearly 300.

Given the high priority placed by the United States on protection of the marine environment, more marine preserves will likely be established through 2020. The priority of the National Marine Sanctuaries will continue to be the long-term protection of U.S. natural resources. More coastal areas (See Table III-1) are likely to be designated as National Marine Sanctuaries, largely due to increasing development of mineral, hydrocarbon, living marine and gravel resources.

CANDIDATE OFFSHORE AREA	REASON
Alaska	Protect living marine resources' habitat
California	Pressure from Environmental & Recreational Groups
Texas	Protect areas from Gas & Oil Industry
Louisiana	Protect areas from Gas & Oil Industry
Florida (East Coast)	Pressure from Environmental & Recreational Groups
Eastern/Mid-Atlantic States	Pressure from Environmental & Recreational Groups

Table III-1. Candidate Areas for New National Marine Sanctuaries. [12]

[11] National Marine and Fisheries Service, "Marine Mammal Stock Assessment Report," accessed online, URL:<http://www.nmfs.gov/tmcintyr/mammals/sa_rep/sar.html>.

[12] Richard D. Kohout and others, Looking Out to 2020: Trends Relevant to the Coast Guard, (Alexandria, VA: Center for Naval Analyses, 1997), 153.

b. Exploitation of Non-living Marine Resources

The rapidly growing and interdependent international community of 2020 increasingly will probe and exploit the oceans for minerals and energy to fuel its expanding economy. Increasing world demand, improving technology, and decreasing availability of some resources on shore will stimulate greater seafloor exploration and development. Furthermore, exploration, drilling, and mining operations will move farther offshore as new technology advances the ability to operate in deeper waters. Production from the ocean waters themselves, rich in mineral deposits and holding tremendous energy potential, may become commercially viable, at least in some regions. Consequently, intensive commercial operations on and under the sea, including along the U. S. coasts, will greatly increase by 2020, presenting new and greater challenges to both the protection of the ocean environment and the safety and security of the people operating in that environment.

(1) Ocean Minerals. The marine mineral industry will be substantially more robust by 2020. Currently, the industry is active in exploration offshore, but production is limited to a few commodities such as sand and diamonds. In the short term, prohibitive costs and environmental concerns will hinder significant industry expansion beyond exploration. However, technological advances derived from deepwater oil exploration and production and, in some cases, increasing mineral prices may make marine mining ventures in several minerals profitable. Dr. James Hein, an International Marine Minerals Society Executive Board member from the U.S. Geological Survey, believes ocean mining "could be a profitable commercial industry around the year 2020 to 2025, but new companies are starting to see huge profit potential, so it could be sooner."[13]

Diamond mining off the South African coast offers a clue to the future of marine mineral mining. The South African offshore diamond mines operate in depths of 100 meters, and are continuously moving to deeper waters, according to Dr. Charles Morgan of the University of Hawaii's Marine Minerals Technology Center. In fact, the marine mines have actually become more profitable than diamond mining on land. Diamond mining occurs off the Namibian coast as well, where it is a billion-dollar industry.[14] Technology developed in sophisticated marine diamond mining operations may be applied to mining for other minerals as well, decreasing development costs.

[13] Daron Jones, "Marine Minerals Mining: Entering a New Age of Feasibility?" UnderWater Magazine (Spring 1998): accessed online.

[14] ibid.

Figure III-3. Sand along a New Jersey beach is replenished to combat coastal erosion.

The most sought-after mineral commodity from the U.S. outer continental shelf during the next 20 years will continue to be sand and gravel.[15] Offshore sand and gravel is used primarily for beach restoration, coastal protection, and construction material. Through 2020, the demand for offshore sand and gravel likely will increase as land supplies begin to diminish and storms continue to erode beaches. Moreover, recovery operations will move farther offshore to avoid damaging coastal areas. There are immense sand and gravel reserves on the outer continental shelf, with estimates of over 2 trillion cubic meters on the Atlantic shelf alone.[16] Already, six large sand-dredging projects are operating on the outer continental shelf along the Gulf and Atlantic coasts.[17]

In addition to sand and gravel, the oceans surrounding the United States contain a wide variety of mineral resources. These minerals are found on the continental shelf, in ocean basins, or dissolved in ocean waters. In the U.S. EEZ, potential mining prospects include:

- Phosphate beds from North Carolina to northern Florida
- Titanium-rich heavy mineral sands from New Jersey to Florida
- Gold-bearing sand and gravel deposits off the Alaskan shore
- Barite deposits off Southern California

[15] Marine Minerals Management Service, "Year of the Ocean: Ocean Energy and Minerals: Resources for the Future," accessed online, URL: <http://www.mms.gov/ooc/yoto/oceanpaper/tabcontent.htm>.
[16] ibid.
[17] Michael J. Cruickshank, "Waterworld – a 21st Century Reality?" paper prepared for the International Mining Investment and Regulation Direction and Development of the Mining Industry Seminar, July 1996.

- Manganese offshore along the Southern California and Georgia coasts
- Cobalt and platinum-rich seabeds in the Hawaiian EEZ
- Gold offshore near Nome, Alaska.[18]

While marine mineral mining in U.S. waters is not currently active, these minerals could be exploited if price levels rise to the point where offshore operations become profitable. This is a realistic possibility, since mineral prices fluctuate and often move cyclically, depending on demand. In fact, relatively rich deposits of gold were recovered in the waters off Nome, Alaska, from 1986 to 1990, but operations halted when the venture became unprofitable because of declining gold prices.[19] Should the price of particular minerals increase in the future, mining could resume in U.S. waters.

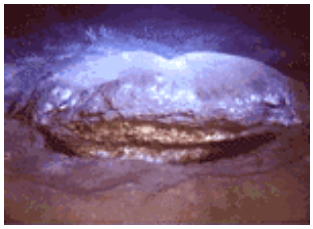

Figure III-4. Left: gas hydrate breaking free from the sea floor (photo by Charles Fisher). Right: irregular pieces of gas hydrate recovered from sediments in the Sea of Okhotsk, east of Sakalin Island.

(2) Methane Hydrates. While vast deposits of methane hydrates in the U.S. EEZ could provide a significant source of energy, commercial exploitation by 2020 is questionable for two reasons. First, a safe and economically profitable technique must be designed to extract the gas. Second, there are still vast deposits of liquid land- and ocean-based methane (natural gas) available for extraction, much of it using existing technology. Even so, Japan has begun drilling an exploratory well for methane hydrate extraction, and the U.S. Department of Energy is researching the feasibility of methane hydrate as an energy source. Should these research and development efforts bring technological breakthroughs, deepwater methane hydrate extraction could become a burgeoning business by 2020.

Methane hydrate deposits are abundant in the U.S. EEZ, especially along the East Coast. There are immense amounts of methane hydrate, concentrated in frozen, ice-like gas

[18] Marine Minerals Management Service, "Year of the Ocean: Ocean Energy and Minerals: Resources for the Future," accessed online, URL: <http://www.mms.gov/ooc/yoto/oceanpaper/tabcontent.htm>.
[19] ibid.

hydrates within the top several hundred meters of sediment in deep water on the continental margins of the United States.[20] Geologists differ widely on the actual amount of methane hydrate available, but a conservative estimate is that the amount beneath the sea floor could double all the known fossil fuel resources worldwide, both exploited and untapped.[21]

Recovering methane gas from beneath the ocean floor presents several safety and environmental challenges. First, methane gas is very unstable and can be dangerous to work with. Second, melting the crystals could destabilize regions of the ocean floor, thus collapsing any drilling rig built there.[22] Finally, the natural venting of unburned methane, a potent greenhouse gas, to the atmosphere may contribute to global warming.[23] Still, with conventional oil and gas production moving into progressively deeper waters in the Gulf of Mexico, the exploitation infrastructure is now in place in those geographic areas where large deposits of methane hydrates are located. This will spur serious research into the viability of methane hydrate as an energy source, and by 2020 may lead to solutions to the safety and environmental challenges posed by methane hydrate production at sea.

(3) Oil and Natural Gas Exploitation. Oil and natural gas exploitation within the U.S. EEZ will continue through 2020. This exploitation will be affected by two factors: continued government restriction and a push to deeper waters. A 1998 presidential directive under the Outer Continental Shelf Lands Act, which limits offshore oil and natural gas development to the Gulf Coast and parts of Alaska through 2012, will continue to stem industry growth in most of the U.S. EEZ. Oil and natural gas developments in water depths greater than 1,000 feet, otherwise referred to as "deepwater" activities, will become an increasingly important part of future production in the few areas where drilling is permitted.

The U.S. Department of Energy forecasts indicate U.S. offshore oil production will increase through 2006 and then decline to current levels through 2020.[24] The projected initial increase is a result of deepwater activities and technological advances. By 2020, offshore production will be characterized by wells located in deeper waters and, as it is today, will be focused in the Gulf of Mexico. Overall U.S. oil production will decline at an average annual rate of 1.1 percent through 2020,[25] while the demand for petroleum

[20] ibid.
[21] "Gas crystals on the seabed could be fuel for the next century," The Times, 8 September 1998, accessed online.
[22] David Graham, "Energy Source of Future May Lie Under the Sea in Methane Deposits," The San Diego Union-Tribune, 3 May 1995, E-1.
[23] Jon Van, "New Energy Source Eyed Under Ocean," Chicago Tribune, 21 February 1995, 3.
[24] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 1998: With Projections to 2020 (Washington, D.C.: U.S. Department of Energy, December 1997), 66.
[25] ibid., 66.

products in the United States is projected to grow by an average annual rate of 1.2 percent.[26] The resulting gap between rising demand and declining production will be satisfied with an increase in foreign imports.

Figure III-5. Oil and natural gas platforms will grow significantly in the Gulf of Mexico by 2020.

The U.S. use of natural gas will increase significantly within the next 20 years in order to meet an increased demand for electricity and to offset a decline in the use of nuclear power. Projections for natural gas production through 2020 indicate an average annual growth rate of 1.5 percent.[27] Natural gas consumption, however, is expected to increase at a slightly higher rate, 1.6 percent per year.[28] Like the oil industry, the difference between domestic demand and supply will be met with increased foreign imports. Net natural gas imports are expected to grow from 12.4 percent of total gas consumption in 1996 to 15.2 percent in 2020.[29] A majority of the imports will come from expanded pipeline growth between the United States and Canada. While most of the imports will come across land, some offshore imports are expected from locations such as Sable Island, Nova Scotia.[30] Liquid natural gas (LNG) will continue to be another source of energy, although less significant.[31] Even so, LNG shipments will remain a maritime safety concern.[32]

The greatest development in the oil and natural gas industries during the next 20 years will be the growth of deepwater activities in the Gulf of Mexico. The expectations are so high that the Minerals Management Service recently published a report entitled Deepwater in the Gulf of Mexico: America's New Frontier. According to the report, "favorable economics, the development of three-dimensional and subsalt geophysical technologies, the announcement of several deepwater discoveries, the development of new deepwater drilling and development technologies, the passage of the Deep Water Royalty Relief Act, and the opportunity to lease new prospects have all contributed to the revitalization of exploration and development in the Gulf of Mexico."[33]

[26] ibid., 4.
[27] ibid., 6.
[28] ibid., 4.
[29] ibid., 61
[30] ibid., 61.
[31] ibid., 61.
[32] Refer to Chapter III, Section A2 for discussion on LNG shipping.
[33] Deborah Cranswick and James Regg, Deepwater in the Gulf of Mexico: America's New Frontier (New Orleans, LA: Minerals Management Service, 1997), iii.

Increased production in the Gulf of Mexico will be offset by reduced production in Alaska. Oil production in Alaska is expected to decline at an average annual rate of 4.3 percent through 2020. The decrease in Alaska's oil production will be driven by the continued decline in production from Prudhoe Bay, the largest producing field, which historically has produced over 60 percent of Alaskan oil.[34]

A moratorium on oil and gas development on the outer continental shelf will remain in effect at least through 2012, thereby limiting activity mainly to Alaska and the Gulf of Mexico. In June 1998, President Clinton issued a presidential directive under the Outer Continental Shelf Lands Act, which extended the moratorium signed by President Bush to protect the coasts from the threat of oil spills.[35] The moratorium prohibits oil and gas drilling and leasing on most of the U.S. outer continental shelf with the exception of the Gulf of Mexico and portions of Alaska. President Clinton's directive also added a permanent ban on oil and gas development in fragile marine sanctuaries.

Another environmental concern is oil transfer operations. Fears of large oil spills along fragile coastal areas, combined with increased imports by large tankers may raise pressure to force oil transfer operations offshore. However, the high cost of offshore oil transfer facilities will limit future progress. Developments such as the Louisiana Offshore Oil Port (LOOP) have been only marginally successful. Despite the environmental benefits the LOOP offers by being so far from shore, it has not generated enough revenue to be profitable.[36] The port of Corpus Christi, Texas, attempted a similar venture on a slightly smaller scale, but after analysis revealed it would take 20 to 25 years to break even, the project was halted.[37] Future prospects for offshore port development are, therefore, considered unlikely.

Figure III-6 Ocean energy conversion is a potential energy source for some U.S. islands, such as Hawaii.

(4) Ocean Energy. Harnessing ocean energy for commercial applications in the next 20 years likely will remain economically unfeasible for large-scale operations, but the potential for small-scale development does exist. Ocean energy does offer a significant source of energy supply, but unless other, currently cheaper sources of energy rapidly diminish, there is little incentive for any significant growth in the industry.

[34] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 1998: With Projections to 2020 (Washington, D.C.: U.S. Department of Energy, December 1997), 66.

[35] "Clinton extends offshore oil drilling ban to 2012," Reuters, 6 December 1998, accessed online.

[36] Richard D. Kohout, and others, Looking Out to 2020: Trends Relevant to the Coast Guard (Alexandria,VA: Center for Naval Analyses, 1997), 120.

[37] ibid., 121.

Ocean Thermal Energy Conversion (OTEC) is one energy conversion process with several applications. These include the following:

- generating electricity
- desalinating water
- supporting deep-water mariculture
- providing air-conditioning and refrigeration
- aiding mineral extraction.[38]

According to the Department of Energy's National Renewable Energy Laboratory in Golden, Colorado, the OTEC potential is enormous. "On an average day, 23 million square miles of tropical seas absorb an amount of solar radiation equal in heat content to about 250 billion barrels of oil. If less than one-tenth of one percent of this stored energy could be converted into electric power, it would supply more than 20 times the total amount of electricity consumed in the United States on any given day."[39]

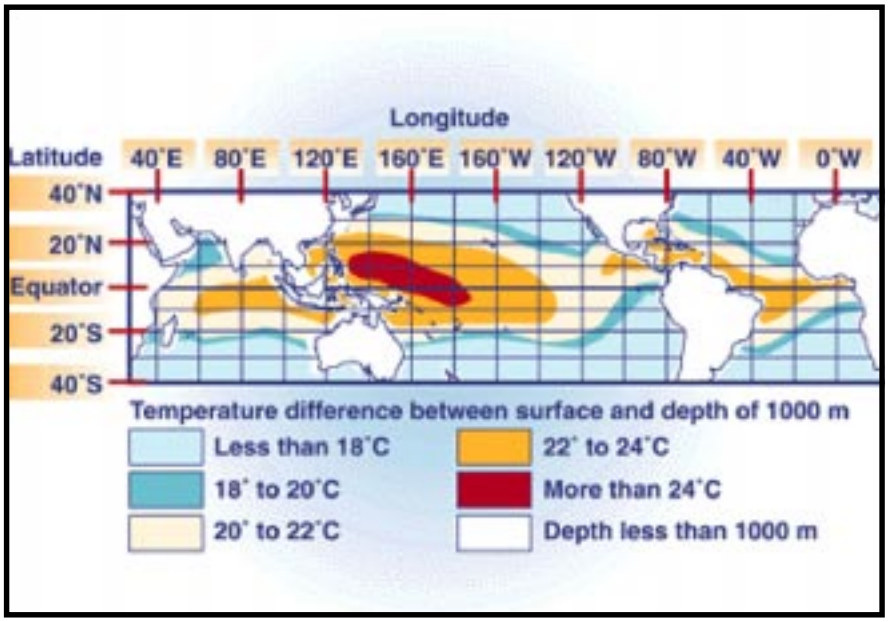

Figure III-7. Ocean Thermal Energy Conversion is possible where surface and deepwater temperature differences exceed 20 degrees Celsius.

OTEC is the process of converting solar radiation to electric power using the ocean's natural thermal gradient to drive a power-producing cycle. "Warm seawater from the ocean's surface and the cold deep water below are pumped through a surface and the cold deep water below are pumped through a heat exchanger that employs a working

[38] National Renewable Energy Laboratory, "Ocean Thermal Energy Conversion," accessed online, URL: <http://www.nrel.gov/otec/design.html>.
[39] ibid.

fluid, such as ammonia, propane, or freon, in a closed cycle. The warm water vaporizes the working fluid, which turns a turbine, thus producing energy."[40] In order for OTEC plants to work properly, the warm surface temperature must differ by about 20 degrees Celsius from the cold deep water.[41] Figure III-1 shows where the 20-degree difference can be found. In the United States, OTEC technology is focused on the Gulf of Mexico, Florida, and islands such as Hawaii, Puerto Rico, and the Virgin Islands.[42] OTEC facilities can be built on land, submerged on the continental shelf, or designed to float on the surface.

OTEC plants could be competitive during the next 5-10 years in three particular markets. However, OTEC competitiveness is highly dependent on other energy source prices. Potential OTEC markets include the following:

- Small, land-based plants producing electricity and desalinated water on Pacific islands.
- A larger land-based plant in Hawaii producing electricity and fresh water.
- Floating systems transmitting electricity to shore in the Caribbean, the Gulf of Mexico, and the Pacific, Atlantic, and Indian Oceans.[43]

The other two types of energy conversion, tidal and wave power, involve the mechanical motion of the ocean. All of the systems developed to capture mechanical energy are designed to supply electricity.[44] Engineers in many countries have developed devices for generating electricity from tidal and wave power. Specially designed turbines mounted in dams or on moorings can capture the energy manifested in elevated sea levels or strong currents.[45] These systems are ineffective, however, where tidal amplitudes are not high, currents are not strong, or wave conditions are inconsistent.

c. Maritime Safety and Security Implications

The growth in marine natural resource exploitation, particularly in the deepwater environment, will bring about new marine safety and security challenges in the years ahead. The year 2020 will likely see more oil and natural gas platforms in deeper waters, more pipelines offshore, increased ocean-based mining and dredging operations, and the possibility of ocean energy conversion facilities. Building, maintaining, and

[40] Richard D. Kohout and others, Looking Out to 2020: Trends Relevant to the Coast Guard (Alexandria, VA: Center for Naval Analyses, 1997), 97.
[41] National Renewable Energy Laboratory, "Ocean Thermal Energy Conversion," accessed online, URL: <http://www.nrel.gov/otec/design.html>.
[42] ibid.
[43] ibid.
[44] Marine Minerals Management Service, "Year of the Ocean: Ocean Energy and Minerals: Resources for the Future," accessed online, URL: <http://www.mms.gov/ooc/yoto/oceanpaper/tabcontent.htm>.
[45] ibid., 5.

servicing these capital projects will greatly expand the amount of vessel traffic and human activity on the seas. While there will be strict regulation of these activities in U.S. waters, regulation alone will not guarantee the safety and security of life at sea nor the preservation of the environment. Substantial monitoring, enforcement, and response capabilities will be required.

Figure III-8. New challenges will emerge over the next 20 years with the development of deepwater platforms.

There will be significant growth in U.S. offshore oil and natural gas platforms and pipelines by 2020. According to the U.S. Department of Energy, the number of oil and natural gas wells, both at sea and on land, is expected to increase between 0.7 and 2.2 percent per year, depending on oil price levels.[46] The greatest growth of offshore platforms will occur on the outer continental shelf of the Gulf of Mexico where the innovative use of cost-saving technology and expected continuation of recent huge finds have encouraged greater interest.[47] Increased oil and gas production in the Gulf will require more pipelines as well. Pipeline construction the Gulf of Mexico is expected to grow substantially since much of its existing pipeline infrastructure is at or near capacity.[48]

Figure III-9. Ruptured pipeline in Texas' San Jacinto River, 1995.

[46] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 1998: With Projections to 2020 (Washington, D.C.: U.S. Department of Energy, December 1997), 60.
[47] ibid., 61.
[48] Deborah Cranswick and James Regg, Deepwater in the Gulf of Mexico: America's New Frontier (New Orleans, LA: Minerals Management Service, 1997), 21.

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The growth in deepwater oil and gas infrastructure and operations will have major implications for maritime safety and security. Deepwater wells may be significantly more remote, increasing emergency response time. The operations may be technically more sophisticated and produce at much higher rates,[49] increasing the scope of potential marine accidents, such as spills. Specific pipeline concerns include:

- Greater environmental risks associated with longer pipelines
- More complex oil-spill contingency plans required for larger pipelines.[50]

The growth of jobs in the deepwater commercial energy sector is another safety concern. More accidents at sea could occur as larger crews begin operating offshore. "Some analysts project that deepwater development in the Gulf of Mexico could create as many as 100,000 new jobs, with up to 70 percent of these sustained beyond 25 years."[51] The response time in the event of an accident will increase as support structures and vessels begin operating farther from shore. The Minerals Management Service estimates that many of the new deepwater facilities will be beyond a 2-hour helicopter flight.[52]

In general, the safety and security concerns brought on by deepwater oil and gas exploitation can be applied to other marine industries as well. While the future for marine mineral mining, methane hydrate extraction, and ocean energy conversion is less certain, operations in any of these fields pose their own risks to the marine environment and place more lives at risk on the seas.

New technologies and larger, more complex facilities associated with deepwater activities could also create conflict ashore. Deepwater resource development will place increased demands on coastal ports and communities for support facilities and services.[53] With an increasing number of entities seeking to exploit ocean resources, conflicts among users could arise. Currently, some communities are opposed to offshore development because of environmental and land-use concerns. Most likely, any deepwater development will be opposed by some environmental activist groups, who may protest ashore or at sea.

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[49] ibid., 3.
[50] ibid., 21-22.
[51] Deborah Cranswick, "Effects of Deep Water Development in the Gulf of Mexico," accessed online.
[52] Deborah Cranswick and James Regg, Deepwater in the Gulf of Mexico: America's New Frontier (New Orleans, LA: Minerals Management Service, 1997), 15.
[53] Marine Minerals Management Service, "Year of the Ocean: Ocean Energy and Minerals: Resources for the Future," accessed online, URL: <http://www.mms.gov/ooc/yoto/oceanpaper/tabcontent.htm>.

ANTARCTICA: A LOOK INTO THE FUTURE

The international competition for Antarctica, for all practical purposes, ended in 1959 with the Antarctic Treaty. Its associated procedures and measures have successfully governed the Antarctic activities of nations for nearly 39 years.[54] The treaty froze existing territorial claims, forbade new ones, banned military operations, and outlawed placement of nuclear weapons and disposal of radioactive wastes in Antarctica.

The 1980s and 1990s have witnessed a commitment to the Treaty system with the adoption of several improvements. Amendments in 1980 limited the exploitation of living marine resources and, in 1991, imposed a 50-year ban on mining. Antarctica will be protected further with the adoption of the Antarctic Environmental Protection Act of 1996 (ratified by the United States in 1997).[55]

As one of the most pristine and underdeveloped regions of the world, Antarctica's natural resources may draw attention as resources are fully exploited in other areas. The anticipated increase in commercial activity in Antarctica will be most notably in tourism and, because of ambiguities in the Treaty amendments and the lack of enforcement presence, harvesting of living marine resources. The number of cruise ships visiting the Antarctic region will increase profoundly through 2020.[56] The sub-Antarctic seas have attracted the fishing industry as nations have closed off their EEZs. The fishing industry is practically non-regulated in this area, and overfishing has caused the near extinction of species such as the Patagonian toothfish (also known as Argentine Sea Bass). Another concern is the potential drilling for offshore oil deposits. The U.S. Geological Survey believes that oil will be the only mineral exploited in the next two to three decades, and then only if drilling technology suitable to the unique conditions of the Antarctic becomes available and market conditions make it economically attractive.[57]

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[54] John M. Collins, Military Geography: For Professionals and the Public (Washington, D.C.: National Defense University Press, 1998), 223.

[55] The act extends and improves the Antarctic Treaty's effectiveness to protect the environment by reaffirming the status of Antarctica as an area reserved exclusively for peaceful purposes. The act includes a ban on all activities related to mineral resources except for scientific studies, and implements environmental impact procedures for both government and private activities. The act will not be reviewed for another 50 years.

[56] Interview with Christopher C. Joyner, Professor at Georgetown University, interview with author, 26 January 1999.

[57] Frank G. Klotz, America on Ice: Antarctica Policy Issues (Washington, D.C.: National Defense University Press, 1990), 90-91.

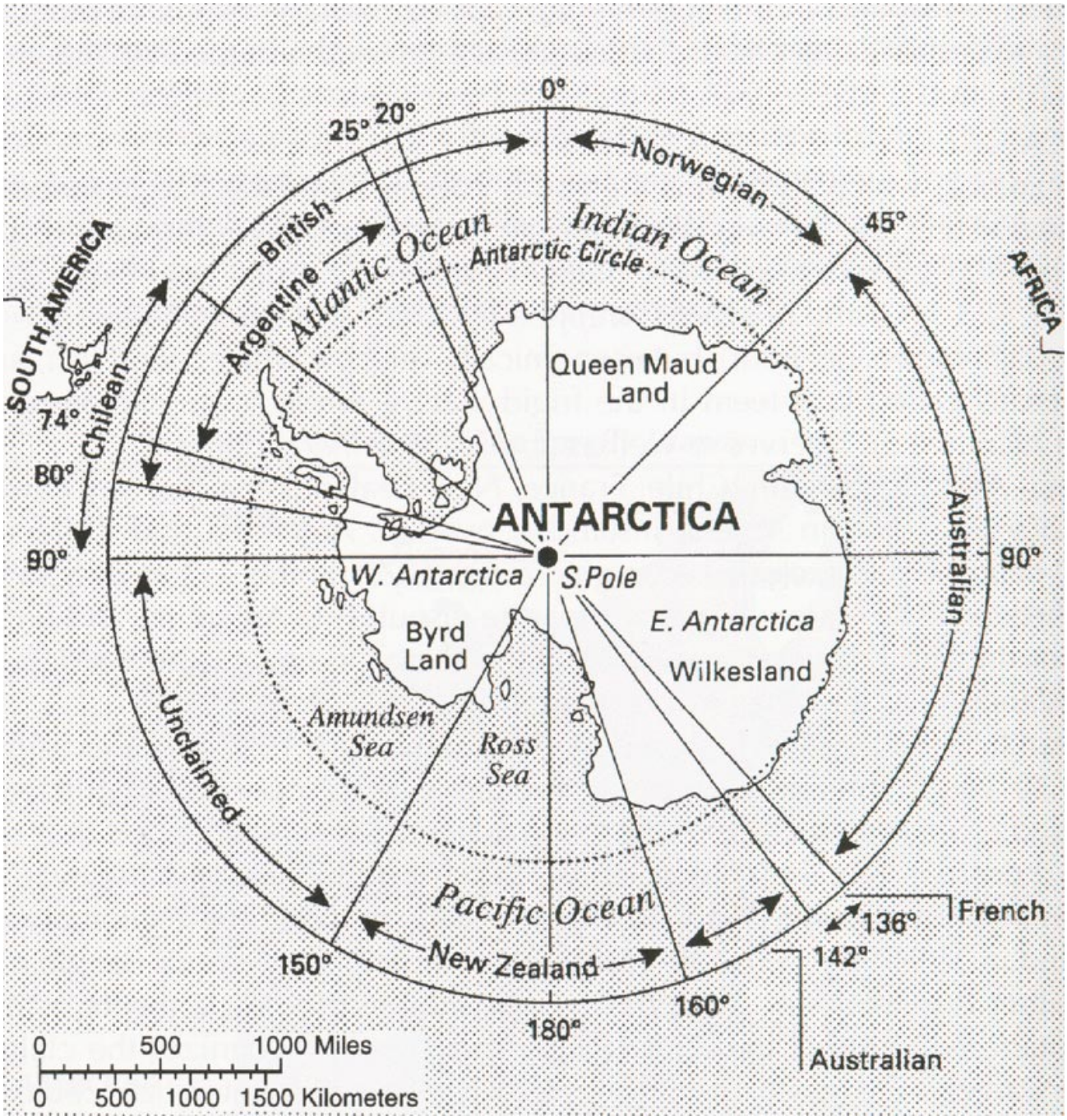

Figure III-10. Territorial Claims in Antarctia[58]

[58] John M. Collins, Military Geography: For Professionals and the Public (Washington, D.C.: National Defense University Press, 1998), 294.

THE FUTURE OF MARITIME ACTIVITIES

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